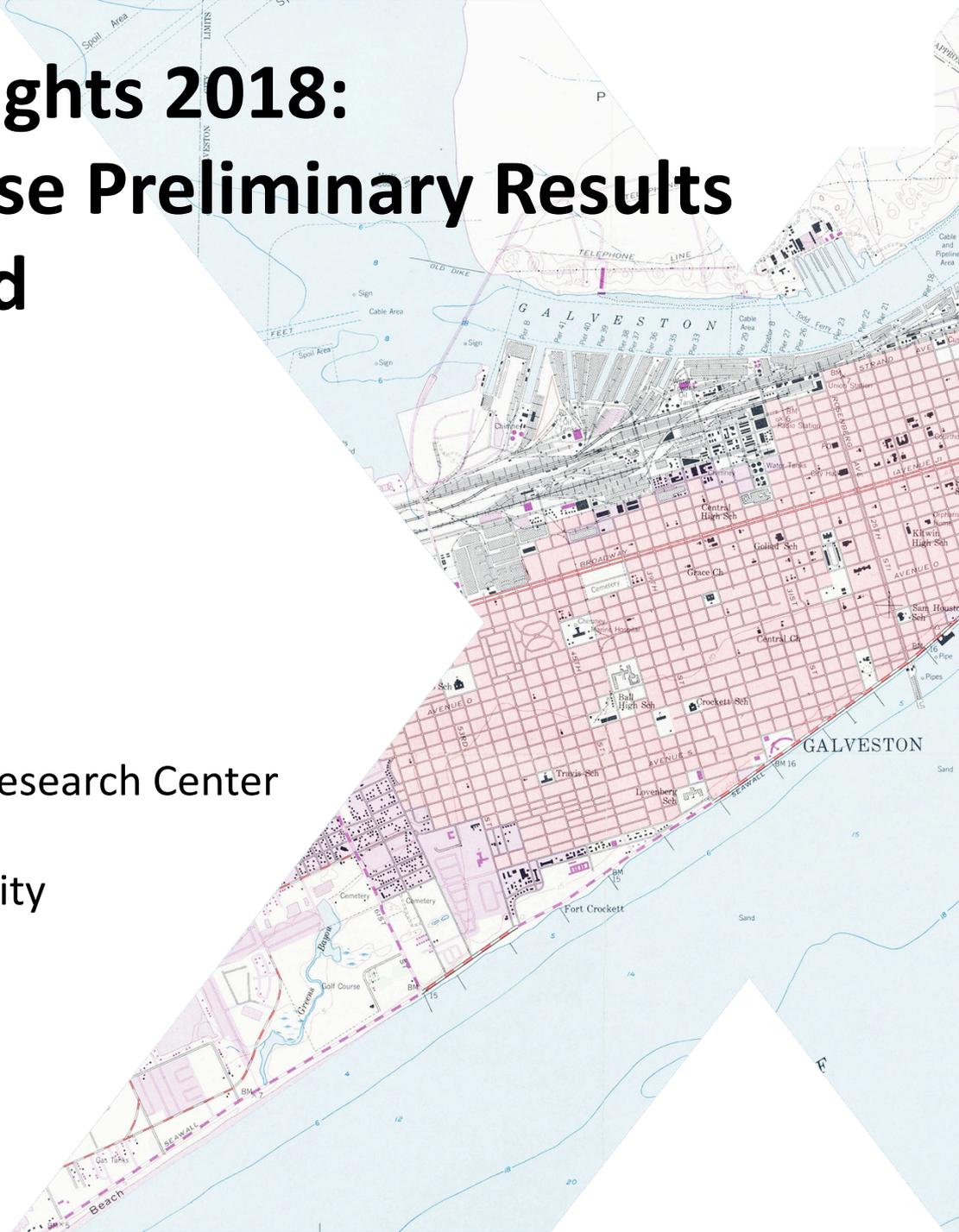


# Quiet Supersonic Flights 2018: Community Response Preliminary Results and Lessons Learned



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June 19, 2019





# Acknowledgements

- Bob Hunte and Dwight Davis, Applied Physical Sciences
- Matt Kamlet, Sasha Ellis, Kate Squires, NASA PAO
- Entire QSF18 Team, with members from NASA, Applied Physical Sciences, Volpe, Penn State, Gulfstream, KBR Wyle, Eagle Aeronautics, Gaugler Consulting, BYU

QSF18 Field Crew (Galveston)

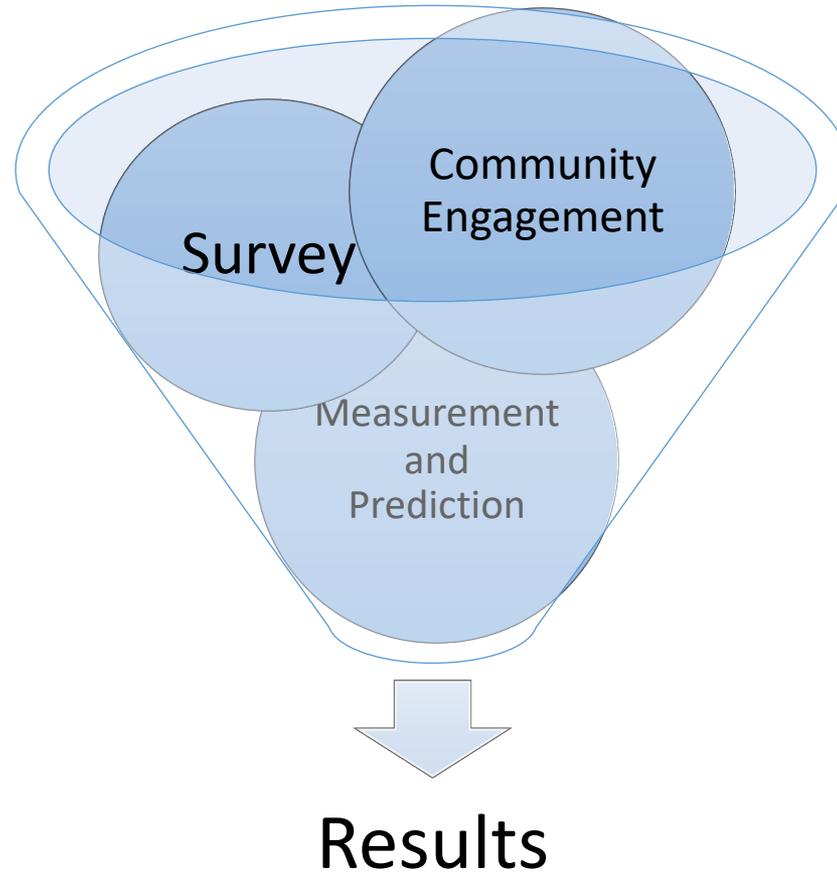


QSF18 Aircraft Operations (Houston)



# Outline

- Low Boom Flight Demo
  - QSF18





# NASA is building a new X-Plane to provide data

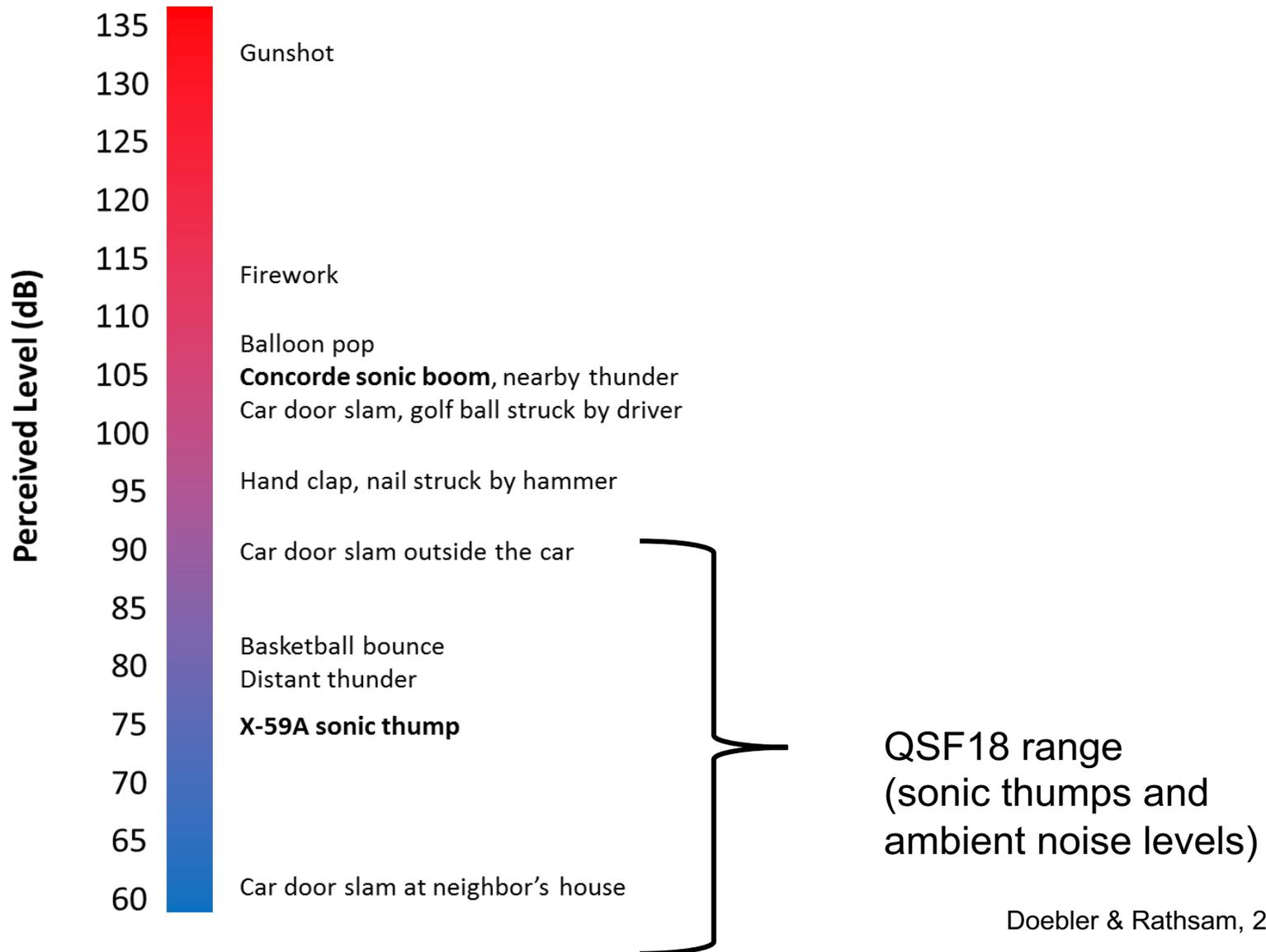
This X-59 QueSST aircraft  
will fly in 2021

Flights will confirm that  
a full-scale supersonic  
aircraft can produce  
just a “thump”

Key data will be gathered on  
public perception of quiet  
supersonic flights in several  
cities across the nation



# “Thermometer” of Impulsive Noise Levels



# Motivation



Before we roll out a national data-gathering effort using the X-plane in a few years, we needed to **test our methodologies** with the help of a city that's not used to hearing sonic booms



## Galveston met all key selection criteria

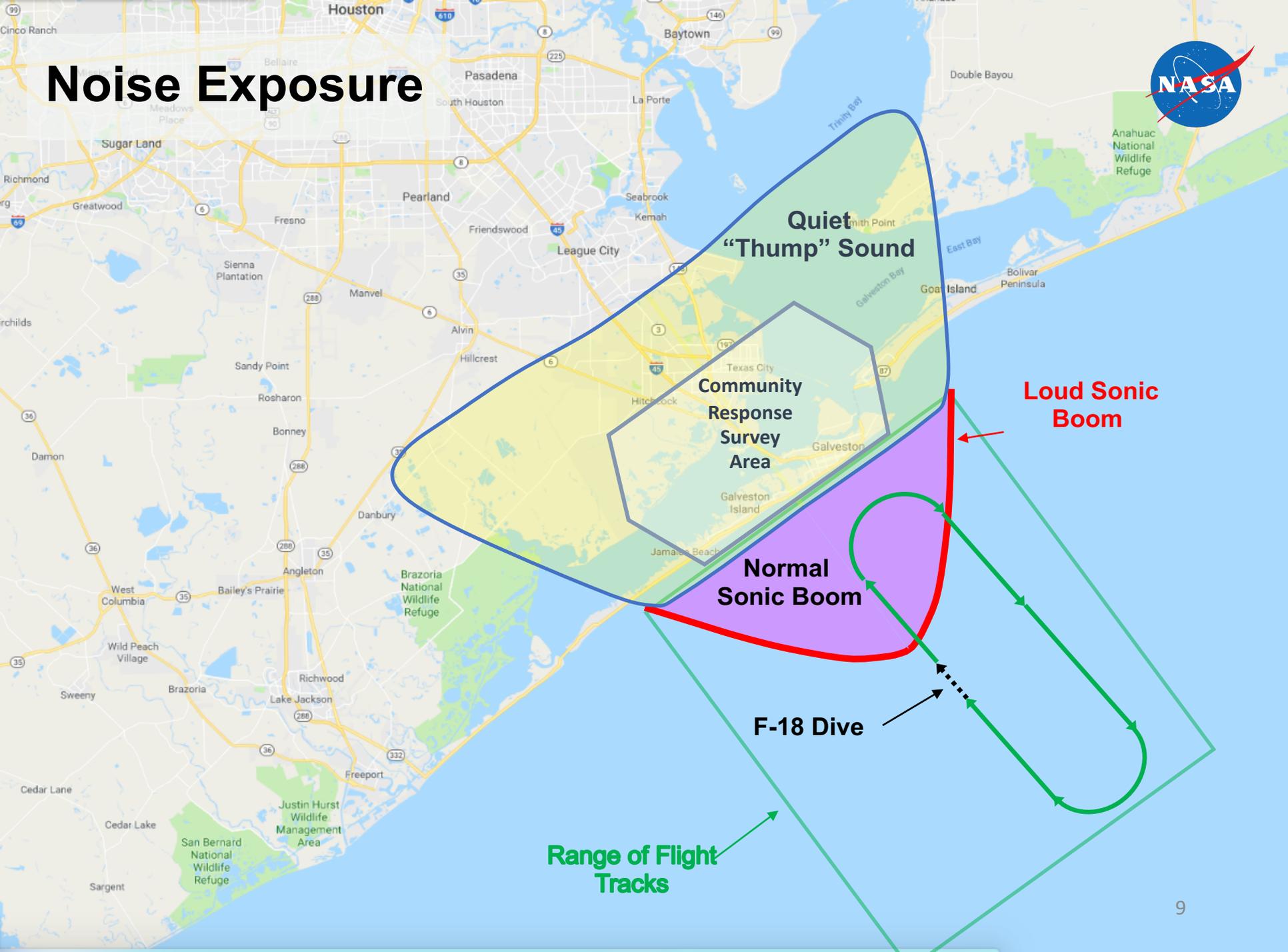
1. Island geography was ideal for sound placement on population.
2. Population density and distribution aided good survey participation.
3. NASA facilities at Ellington Field supported aircraft operations.
4. Local FAA office confirmed operations would have minimal effect on nearby commercial flight operations.

# Flight Test Highlights

1. 9 flight days over two weeks
2. 4 – 8 sonic thumps daily, levels increased gradually
3. 500 members of the public targeted for survey
4. 15 noise monitors to measure sound levels across survey area



# Noise Exposure



Quiet  
"Thump" Sound

Community  
Response  
Survey  
Area

Normal  
Sonic Boom

Loud Sonic  
Boom

F-18 Dive

Range of Flight  
Tracks

# QSF18 Builds on Past Successes



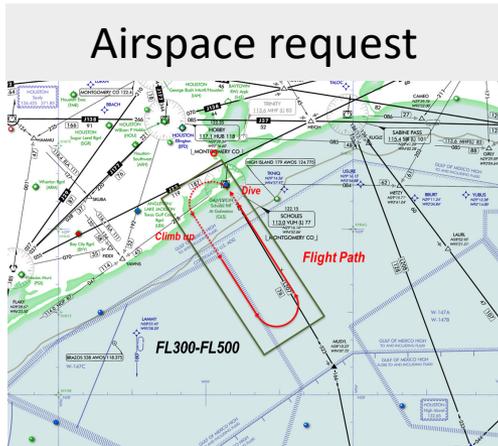
	2011	2017	2018	2023-2026
Aircraft	F-18	F-18	F-18	X-59 QueSST
On/Off Base	On base	On base	Off base	Off base (multiple)
Noise Monitor Coverage Area [sq mi.]	1	12	60	~2000
Number of survey participants	100	61	500	TBD
Number of flight days	10	3	9	TBD
Research Goal	Risk Reduction	Risk Reduction	Risk Reduction	Data for Regulators



# Community Engagement

# Community Engagement: Start early

- Local Air Traffic Control (12 months prior)
  - Confirmed F-18 dive maneuver would not affect local commercial operations
- Elected Officials Briefing (8 months prior)
  - Buy-in from local, state, and federal elected officials
- General Public (7 months prior)
  - Press Conference (targeting impacted community, see pictures below)
  - First responders (Police, Sheriff, Fire, Coast Guard)
  - Special outreach to maritime community
- Survey Participants (1 month prior)





# Community Engagement: During Test

- Public information booths at McGuire Dent Recreation Center in Galveston and Space Center Houston
  - High amount of foot traffic at both locations.
- Online Citizen Science Activity
- STEM Engagements at local schools, “[Seeing Sound](#)” online curriculum
- Media Day, including photo and video provided by NASA
- Community feedback via Social Media, Telephone Hotline, Police, and In Person
  - Inquiries ranged from curiosity to complaints. Most complaints mitigated by NASA PAO.
  - More feedback than expected via social media.

Public Information Booth



Citizen Science Activity



Online Curriculum





# **Sonic Thump Measurement and Prediction**

# Acoustical Measurements



15 Noise Monitor Locations across Galveston County

- Sparse array of noise monitors across survey area
- Ambient noises obscured many sonic thumps. Need to choose monitor locations more strategically.
  - Only 56%, or 266, of 476 possible acoustic measurements were 5 dB above the ambient
- Prediction combined with measurement to determine noise for survey participants
- Automation needed to isolate sonic thump waveforms and calculate noise metrics



# Social Survey



# Social Survey: Planning

Prompt Survey	Cumulative Survey
Perceptions of individual sonic thumps	Perceptions based on all sonic thumps experienced that day

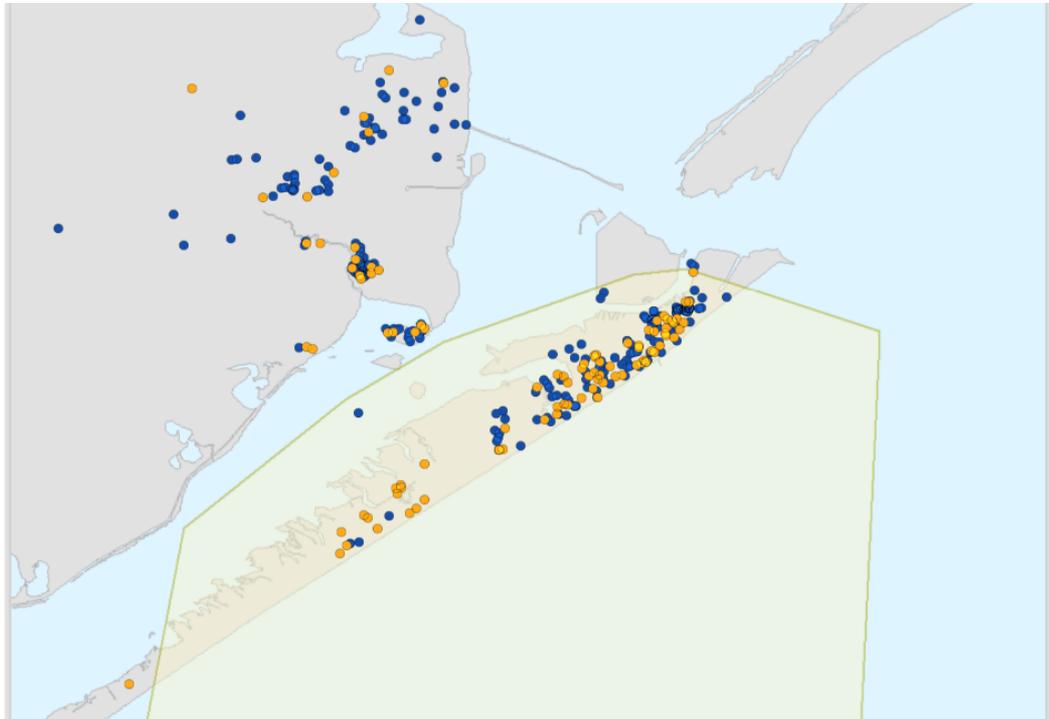
- Paperwork Reduction Act (OMB), Ethical Review (IRB)
- 400-500 participants needed, based on statistical power analysis
- 8000 recruitment letters, including \$2 cash, sent to random sample of residential addresses within survey area. Reminder postcard also sent.
- Participants enrolled via website. Participants had many questions during enrollment.
- Recruitment resulted in 496 enrolled participants.

# Social Survey: Geolocation

- Sonic thump noise levels vary widely across F-18 dive footprint, so participants must be located to assign a specific noise dose.
  - Geolocation app worked for 72% of 11,869 prompt survey responses.

Flight F06P1

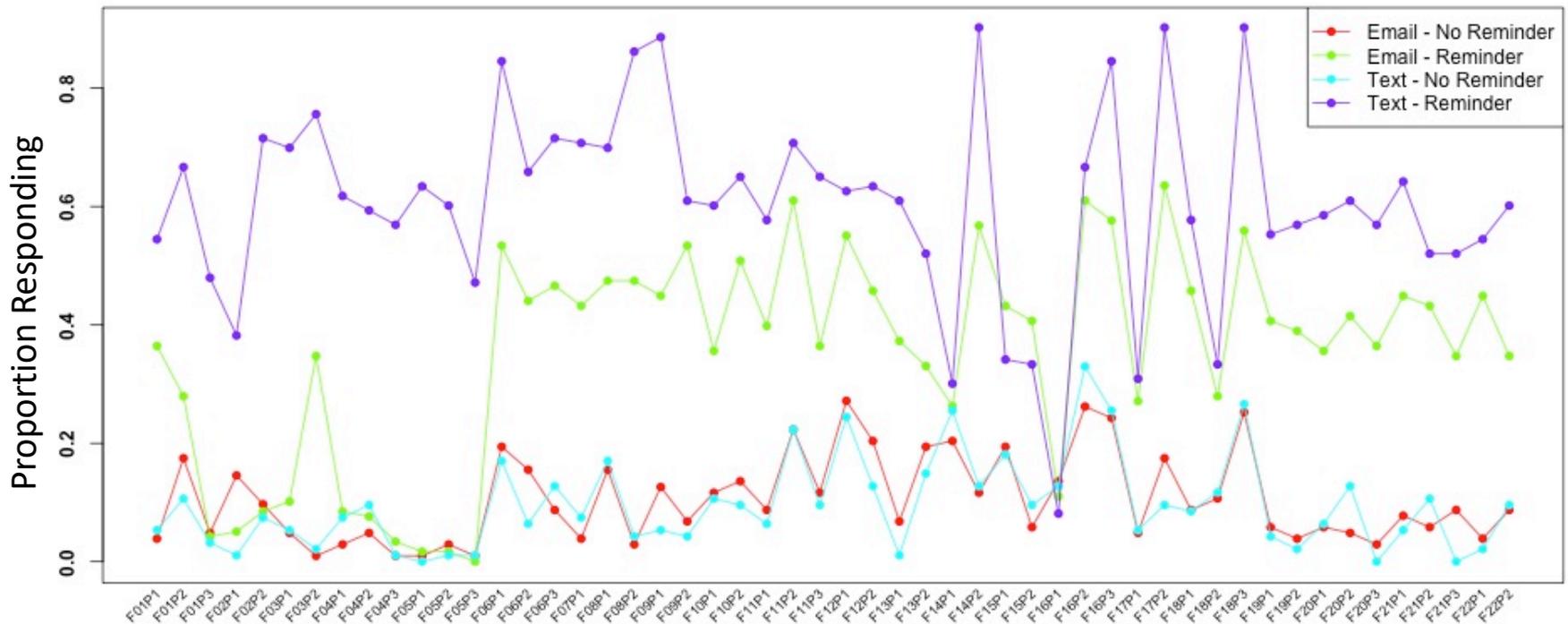
● Heard	98
● Not Heard	223





# Social Survey: Reminders

- Reminder messages improved survey completion rates, especially for thumps not heard.
  - False reminders also sent.





# Social Survey: Analysis

	Potential Responses	Responses Initiated	Responses Analyzed
Prompt Survey	24,792	11,869 (48%)	5,789 (23%)
Cumulative Survey	4,719	2,841 (60%)	2,116 (45%)

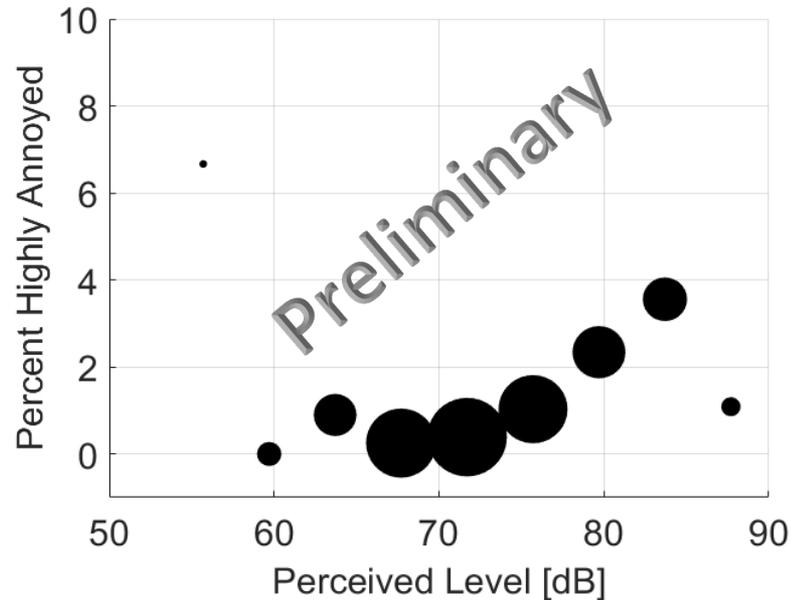
- Of the 496 survey participants, 476 initiated prompt surveys and 429 initiated cumulative surveys
- Automated techniques needed for isolating subset of complete survey responses with valid matching noise dose.



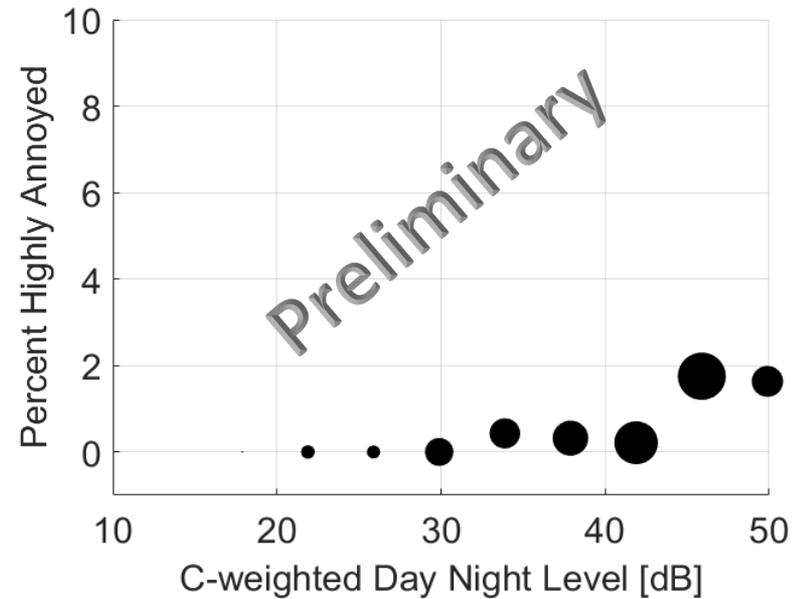
# Preliminary Results

# Preliminary Results

## Prompt Survey



## Cumulative Survey

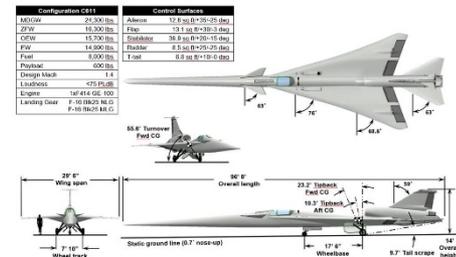


- Datapoint size proportional to number of observations, ranging from 15 to 1,547
- In this dataset, 75 PLdB corresponds to approximately 1% Highly Annoyed
- Datapoint size proportional to number of observations, ranging from 1 to 571



# Conclusions and Implications for X-59

- QSF18 demonstrated that NASA can successfully engage a community in sonic thump community response testing.
  - Engaging communities without a NASA Center will require more planning.
- Acoustic measurements affected by noisy ambient conditions.
  - Solutions needed to account for ambient noise.
- Manual data cleaning and analysis must be automated to meet aggressive test schedule of two deployed tests per year in different locations.
  - Isolate sonic thump waveforms from noisy background and calculate noise metrics
  - Determining subset of usable, complete survey data with matching noise dose
  - Include quality assurance and quality control of incoming data





# Upcoming opportunities to get involved

- June 7, 2019: [Sources Sought Notice](#) released for X-59 community response testing, which closes July 8, 2019. Search fbo.gov for solicitation number SS-X59CRT.
- Fall 2019. QSF18 Technical Report to be published.
- Dec 2—6, 2019: Special Session on QSF18 at Acoustical Society of America meeting in San Diego.

Flight Control Room



F-18 takes off from Ellington



Noise monitor in Galveston





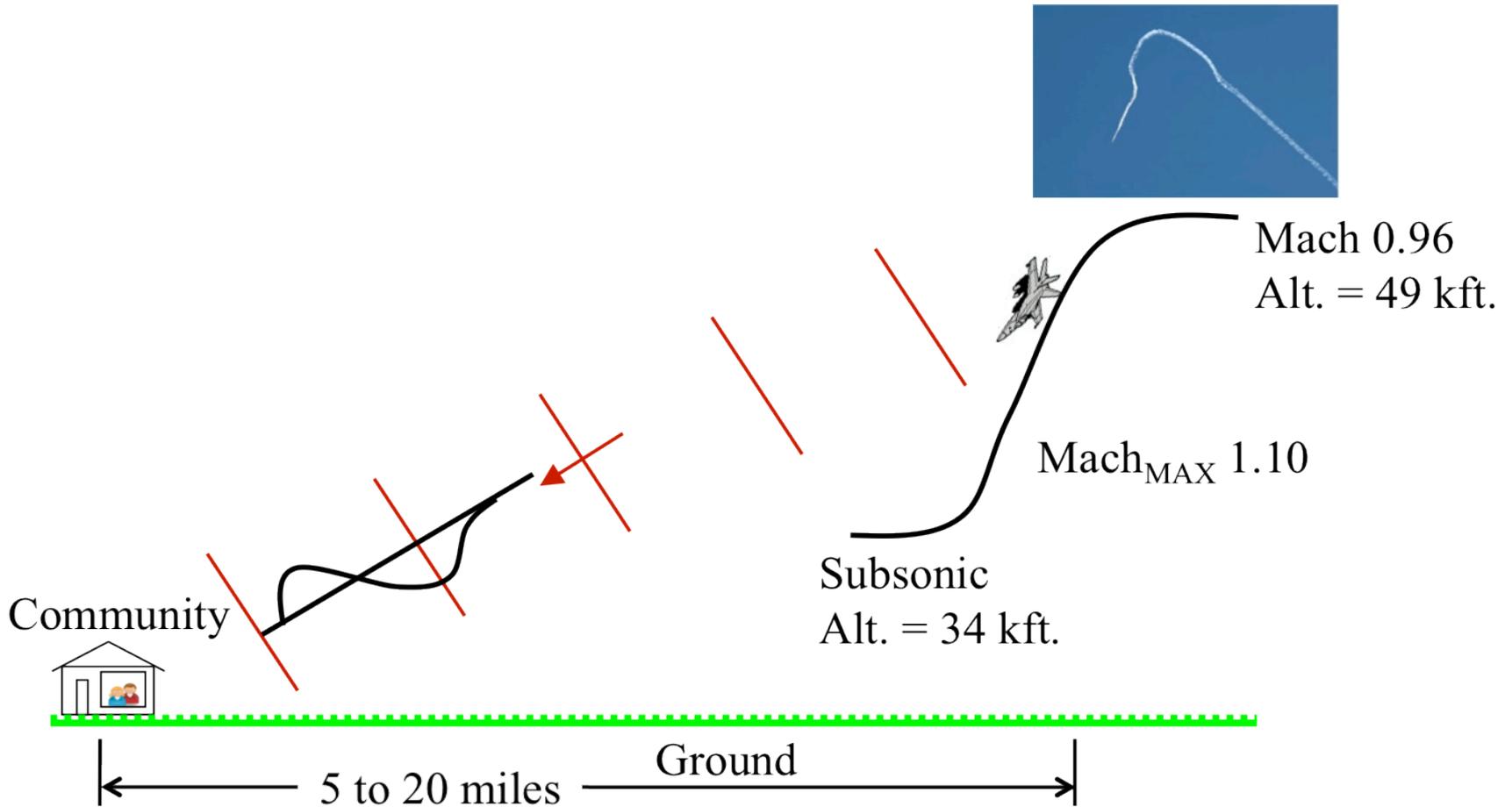
# References

1. W. Doeblner and J. Rathsam, “Stevens perceived levels of common impulsive noises, sonic booms, and sonic thumps” Presented at 177<sup>th</sup> Meeting of the Acoustical Society of America in Louisville, KY. May 2019. <https://doi.org/10.1121/1.5101887>



# Backup

# F-18 Dive Maneuver





FAA-coordinated Air Traffic Control Assigned Airspace (ATCAA).

Altitudes between 30,000 – 50,000 ft.  
Higher than civil/commercial airplanes

Specialized airspace codename: “Whisper”



# NASA Response to Damage Claims

- Any members of the public who call in to claim property damage as a result of sonic thumps from QSF18 flights will be directed to download the Standard Form 95 (SF-95), fill it out, and submit it to NASA Johnson Legislative Affairs. NASA Johnson Legislative Affairs POC will be available for counsel, and will be involved in reviewing any legal claims.
- [Link to the SF-95 form.](#)

<b>CLAIM FOR DAMAGE, INJURY, OR DEATH</b>		<b>INSTRUCTIONS:</b> Please read carefully the instructions on the reverse side and supply information requested on both sides of this form. Use additional sheet(s) if necessary. See reverse side for additional instructions.			FORM APPROVED OMB NO. 1105-0008
1. Submit to Appropriate Federal Agency:			2. Name, address of claimant, and claimant's personal representative if any. (See instructions on reverse). Number, Street, City, State and Zip code.		
3. TYPE OF EMPLOYMENT <input type="checkbox"/> MILITARY <input type="checkbox"/> CIVILIAN		4. DATE OF BIRTH	5. MARITAL STATUS	6. DATE AND DAY OF ACCIDENT	7. TIME (A.M. OR P.M.)
8. BASIS OF CLAIM (State in detail the known facts and circumstances attending the damage, injury, or death, identifying persons and property involved, the place of occurrence and the cause thereof. Use additional pages if necessary).					
9. <b>PROPERTY DAMAGE</b>					
NAME AND ADDRESS OF OWNER, IF OTHER THAN CLAIMANT (Number, Street, City, State, and Zip Code).					
BRIEFLY DESCRIBE THE PROPERTY, NATURE AND EXTENT OF THE DAMAGE AND THE LOCATION OF WHERE THE PROPERTY MAY BE INSPECTED. (See instructions on reverse side).					